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FOREST UTILIZATION IN PUERTO RICO

By

C. C. BELL, Chief
Forest Utilization Service

August 15, 1952

UNITED STATES DEPARTMENT OF AGRICULTURE
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TABLE OF CONTENTS

	Page No.
Introduction	1
The Situation	2
Economic Background	2
Agriculture	3
Manufacturing	4
Import and Export Trade	4
The Forests	5
Forest Areas and Their Condition	5
Forest Volumes	7
Forest Use	8
Forest Problems	9
Forest Utilization	9
Wood Use and Raw Material Sources	10
Insular Production	12
Fuelwood and Charcoal	12
Lumber	13
Local-use Material	13
Wood Use	14
Construction	14
Furniture	15
Millwork	16
Minor Industries and Uses	17
Paper and Products	18
Factors Affecting Wood Use	20
Accomplishments in Forest Products Research	22
Wood Properties	22
Seasoning	23
Natural Durability	24
Preservative Treatment	24
Industrial Use	25
Summary and Recommendations	25
Summary	25
Economic Background	25
The Forests	26
Forest Utilization	27
Accomplishments in Forest Products Research	29
Recommendations	30
Forest Economics	30
Forest Products	31
Derived Products	31
Industrial Investigations	31
Pulp and Paper	32
Silvicultural Relations	32
Timber Mechanics	33
Timber Physics	33
Wood Preservation	33
Activation of Recommendations	34

TABLE OF CONTENTS (Continued)

	Page No.
Appendix	36
References	36
Tables	37
1--Net income of the United States and Puerto Rico by industrial orgin	37
2--Components of gross income and gross product of Puerto Rico	38
3--Employment status of Puerto Rico population	39
4--Total production and gross income from agriculture	40
5--Manufacturing in Puerto Rico	41
6--Value of Puerto Rican imports and exports of forest products	42
7--Wood volume on forest lands in Puerto Rico	43
8--Volume of Puerto Rican imports of forest products	46
Illustrations	
1 - The best of the "Timber Forest"	6a
2 - About 550,000 cords of pulpwood are available for utilization in western Puerto Rico	8a
3 - Puerto Rico's saw-timber stand and drain are very small	8b
4 - A major forest problem is to increase the use of small, poor-quality and poor-form material	9a
5 - Charcoal is produced by the old "beehive" method	12a
6 - Whipsawing tabonuco on the Luquillo National Forest Unit	13a
7 - The use of native "sprouting species" is a partial solution to the fence post deterioration problem	14a
8 - The typical furniture factory uses small-sized equipment, has no factory trucks, and does the minimum of housekeeping	15a
9 - Wood seasoning is given little attention by Puerto Rican fabricators	15b
10 - Furniture made in Puerto Rico looks good, but may not always give good service	16a
11 - Millwork production is mostly by plants which are comparatively large and well equipped	17a
12 - The use of native woods can be increased in the broom industry	18a
13 - Native woods with a value of 25 cents can be converted into a product selling for $50	18b

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Forest Products Laboratory,[1] Forest Service
U. S. Department of Agriculture

INTRODUCTION

The period of May 14 through June 19, 1952, was spent by the writer in Puerto Rico at the request of the Director of the Tropical Region and the Washington Office of the Forest Service. In general, the objective of the assignment was to become acquainted with the forest- and wood-utilization problems of the Island and to recommend actions to alleviate or to solve those problems which fall within the field of forest products research and application.

Twenty-five working days were spent in Puerto Rico, of which about one-half were assigned to visits and inspections of the National Forest, other forest lands, experimental forest areas, and wood conversion and wood fabricating plants -- some 60 plants were visited. The balance of the time available was spent in office conferences, interviews, etc., and in the office review of pertinent records, reports, and other references.

Assistance and cooperation from all concerned with the assignment were of a high order. It is impractical to list the names and connections of all who were helpful, but special appreciation is due to H. B. Bosworth, Director of the Tropical Region, for contributing a great deal of his official and personal time in the office and field and in planning, facilitating, and discussing the assignment; to F. H. Wadsworth, in charge of Forest Research, Tropical Region, for similar assistance and for contributing much on Puerto Rico's history, economics, and forest research results and needs; to José Marrero, Forest Management Research Tropical Region, for field and office assistance in connection with plant and field visits; to Julio Rodriquez-Piñan, Insular Forest Service, for help on plant and office visits and other assistance; to Ben. R. Seda and his staff, Insular Forest Service, for information on the results of the Insular Forest Survey; to Angel L. Ferrer, Fiscal Agent, and Ana T. Vega de Jiménez, Secretary to the Director, Tropical Region, for general facilitating assistance; and to Horace Kumin, Puerto Rico Economic Development Administration, for supplying a card list of wood-using industries and other information.

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

This report is overly long in relation to the general objective. Readers who are not interested in details can get the substance of it from the "Summary and Recommendations". Considerable detail has been included for reference purposes in case one or more employees of the Tropical Region are assigned to the forest products field. In addition, a rough transcript of notes on plant visits is being sent to the Tropical Region.

THE SITUATION

As a Spanish colony from 1508 until 1898, and as a United States insular possession (now Commonwealth) since, Puerto Rico has survived 444 years of colonial status accompanied by considerable exploitation of its resources and its people. Originally with few natural resources other than soil and timber, both have been used to a near maximum. Now agricultural soils require heavy fertilization and the supply of timber, as we understand "supply" in the States, is nearly exhausted. Exclusive of silica, lime and clay deposits, and small amounts of a few minerals, there are no other natural resources. There are some natural advantages, however, including a 12-month growing season and a climate, terrain, and sightseeing attractions upon which to expand a tourist industry.

In Puerto Rico about 2.25 million people live on 2.2 million acres of land--only about one-half of which is suited to agricultural use and only 28 percent of which should be cultivated continuously. Population density is about 14 times that of the United States and population increase about twice the United States rate. Although by Caribbean standards the people are fairly prosperous (Cuba, Jamaica, and the Dominican Republic all have lower per capita incomes), by United States standards their median income is pathetically low--being only about 28 percent of the United States ($378 vs. $1,330 in 1949).

In more specific terms, Puerto Rico has 44 percent of the area of New Jersey and 49 percent of the New Jersey population. Continuing the comparison, the population increase of Puerto Rico is twice the New Jersey rate, Puerto Rico per capita income is 22 percent of that in New Jersey, while total farm income is 65 percent. Industrial employment, however, is only about 3 percent of New Jersey.

ECONOMIC BACKGROUND

Table 1 (Appendix) gives the distribution of Puerto Rico's net income by origin in comparison with that of continental United States. Of interest are the following points:

1. The Puerto Rican economy is dominated by agriculture (21.5 percent) to a much greater extent than in the United States (7.4 percent);

2. Manufacturing is a relatively minor income producer (13.9 percent) in Puerto Rico in comparison to the United States (31.0 percent); and

3. The costs of Puerto Rican government are high (20.4 percent) in comparison to United States costs (9.8 percent).

As a further hint to the economic problems of Puerto Rico an examination of the Insular gross product (table 2), or consumption expenditures, shows, as "External Balance," $204 million in Fiscal Year 1951. This amount was spent on the Island in excess of the income earned there. That is, the economy of Puerto Rico is maintained from outside sources to that extent, mostly by United States subsidies and other disbursements.

Another discouraging factor in the Puerto Rican economy is that full employment cannot be found for its people. Table 3 points up this fact. Even though employment increased from 512,000 in 1940 to 685,000 in 1950, unemployment increased from 66,000 to 89,000 over that period. One commentator (1)[2] has said that this is an Alice-in-Wonderland condition in which Puerto Rico, to keep its people employed, has to "run very fast to stay where she is."

In addition, wages are low in Puerto Rico by continental United States standards. In 1951 the average wage was 45.3 cents per hour, ranging from 62.4 cents in the fabricated metal products industry to 28.6 cents in the tobacco products industry. The lumber and furniture industries paid a wage of 43.5 cents. Even though low in comparison to those of the States, these wages are high in the Caribbean and tropical American area, with the result that, in general, Puerto Rico can compete only on the United States market in the sales of products in which wages are a determining factor.

Agriculture

As indicated previously, the Puerto Rican economy is largely agrarian, sugar cane being the dominant crop. The sugar season (January to June) is so important to the people that it has been given a special name "Zafra" and outside this season many people are unemployed. About 35 percent of the harvested crop land is devoted to sugar and good cane land is reported to be selling for as much as $1,500 per acre. The production and gross income from agriculture is given in table 4. In

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[2]See "Appendix-References" for material sources.

1948 sugar and molasses made up about 63 percent of the value of all crops. Stimulated greatly by the United States acquisition of the Island, the production of sugar has leveled off during recent years to a steady 1.3 million short tons. In general, this also means that agricultural employment has stagnated and that the increasing labor force will have to look elsewhere for employment.

Manufacturing

The production of manufactured products has been increasing in Puerto Rico and has been able to absorb some of the population pressure. From 1939 to 1949 the number of Puerto Rican establishments increased from 800 to 2,000, the number of employees from 26,000 to 55,000, and the value added by manufacture from $35.2 million to $93.4 million.

From table 5 it will be seen that manufacturing is dominated by food and food products industries, of which raw cane sugar is the principal component. The wood industries are of minor importance. Including lumber, furniture, and paper, they total only 12 percent of the number of establishments, 4.5 percent of the number of employees, and 4 percent of the manufacturing value added.

Import and Export Trade

Until 1938 Puerto Rico generally exported a larger value of goods than she imported. Since that date the Puerto Rican balance has been unfavorable, not because of a decline in exports but because of an increase in imports. In 1950 the negative trade balance was $110 millions. About 90 percent of the Puerto Rican imports are from the United States. Major items of export are sugar and molasses (about 60 percent of the total), needlework, and tobacco. Imports run the gamut of products -- food items, automobiles and machinery, and cotton goods being some of the major ones.

Imports of forest products are a substantial item (about 5 percent of all imports) amounting to a value of $16.8 millions, of which $15.2, or 90 percent, are from the United States (see table 6). Puerto Rico exports (mostly by transshipment in the Caribbean area) some forest products but has a net negative balance of $16.4 million. The major items of forest products imports are rough, dressed, and patterned lumber (largely southern yellow pine), $5.5 million; furniture, $1.7 million; paper and products, $6.6 million. Imports of forest products supply employment elsewhere to some 1,500 to 2,000 workers. Puerto Rico pays ocean freight on these imports amounting to about $3.0 million annually.

THE FORESTS

Since the land-use pattern in Puerto Rico changes rapidly, it is almost impossible to determine the area of forest land. The urgency of the dense population to eke out income and food from the soil moves land into and out of cultivation each year. Factors affecting soil-use, such as a change in the sugar quota assigned to Puerto Rico by the U. S. Department of Agriculture, result in cultivation movements up and down steep hillsides with much crop production on fields with slopes of about 45 degrees.

The U. S. Soil Conservation Service has developed a classification of the "Capabilities of Puerto Rican Soils for Agriculture," which gives the following:

Land capability	Area in acres (Thousands)	Percent of Puerto Rico area
Continuous cultivation	603.6	27.5
Occasional cultivation	91.7	4.2
Pasture with simple conservation practices	494.3	22.6
Forest or, in some cases, pasture with complex conservation practices	917.9	41.9
Unsuited for agriculture	52.3	2.4
Unavailable for agriculture	30.9	1.4
	2,190.7	100.0

Misuse of areas best suited to forest cover has resulted in substantial soil-erosion and flood-damage problems. Reservoir sedimentation has progressed at such a rate that one reservoir has lost 69 percent of its capacity in 31 years. About 280,000 acres are subject to flood damage, due in part to lack of adequate forest cover.

Forest Areas and Their Condition

In contrast to a land-management objective of some 900,000 acres in forest land, between 600,000 and 700,000 acres are now in brush cover, forest, or forest pasture. This is private land with the exception of 83,000 acres, or about 13 percent, of which 33,000 acres are in National Forests and 50,000 acres in Insular Forests. In general, three public forests cover terrain which is extremely rugged, interspersed with some tillable land.

The substance of one analysis (2) of the condition of Puerto Rico's forests is given below.

	Acres
Timber forests	119,000

These areas mostly have been repeatedly cut over, removing the larger and more useful trees until now they are composed largely of trees of poor quality. Eighty percent of the areas has been cleared at one time or another for temporary cultivation.

Forest-covered coffee plantations	140,000

The coffee-plantation shade cover is usually not made up of good timber species. Utilization mostly is limited to posts or fuelwood. These areas often are in various stages of abandonment and are reverting to secondary forests.

Woodland pasture	20,000

Forty percent or more tree shaded, this area is heavily grazed and yields of both forage and timber are low. The tree cover is usually of poor form and of poor species and grazing prevents reproduction.

Orchards	1,000

Mostly of bay rum and citron. Little yield of timber.

Brush lands	320,000

These areas bear almost no tree cover and produce little wood other than fuel. They are cultivated intermittently and revert to young trees, shrubs, brush, and vines.

Total	600,000

These general situations are complicated further by a wide range of altitudes (sea level to 4,400 feet), a wide range of rainfall and other growing conditions and a multitude of species -- many of little known value. Some 600 species have been recognized on the Island and 320 species were recorded in commercial volumes in a recent forest survey.

Figure 1.--The best of the "Timber Forest", virgin timber, Luquillo Unit, Caribbean National Forest. Total acreage of this quality and density of stand is now very very small. (Photo. by F. H. Wadsworth, 1947)

Forest Volumes

From the above it can be assumed correctly that nearly 450 years of use and abuse have reduced the forest volume of Puerto Rico to a near minimum. Several official estimates of volume have been made but, until lately, there have been no bases for these estimates other than observation and limited sampling.

In 1948 to 1951, the Insular Forest Service conducted a forest survey of Puerto Rico following largely the techniques used by the U. S. Forest Service. The results of this survey are given in table 7, from which the volumes reported are converted and summarized below:

Forest Volumes in Puerto Rico
(As reported by the P. R. Forest Service)

Type of material	Volumes			Percent (of cubic feet)
	M bd. ft.	M cu. ft.	M cords	
Saw timber	69,348	10,365	115	7.9
Poles	218,387	32,595	362	24.9
Fuelwood	589,660	88,009	978	67.2
Totals	877,395	130,969	1,455	100.0

The inadequacy of this supply is emphasized by the fact that in Fiscal Year 1950 Puerto Rico imported the equivalent of 89,000 M board feet of lumber and manufactured wood products and 37,600 tons of paper products. In cordage equivalents, imports thus were 318,000 cords or about 22 percent of the total Insular supply. In lumber and manufactured wood products, imports were 128 percent of the Insular saw-timber supply.

The above (plus table 7, plus the previous discussion under "Forest Areas and Their Condition") points up the following:

1. The saw-timber volume of the Island is very small (about 70 million board feet) and scattered over 325,000 acres. Much of it is inaccessible, of poor form, or of poor species.

2. The pole volume is larger (218 million board feet) but is almost as widely scattered and occurs at a volume rate of about 1.5 M board feet per acre. (Actually, most pole-sized timber is utilized as fuelwood because of lack of market and scattered volumes.)

3. Over two-thirds of the total Insular forest volume is in fuelwood and pulpwood sizes (mostly below 6 in. d.b.h.) and is available in average volumes of 2.9 cords per acre. (Actual volumes exceed this since material below 3.6 inches d.b.h. was excluded from the survey.)

Concentrated along the mountainous "backbone" of the Island, and in the western 40 percent of its length, is a large percentage of the total material available for fuel and pulpwood. This is generally of poor quality, poor form, or small size. The supply in this area is estimated at a minimum of 49 million cubic feet (excluding woodland pasture, and mangrove) of which 37 million cubic feet are on the north slope (contributory to Arecibo) and 12 million cubic feet on the south slope (contributory to Ponce). The total area involved is 194,800 cuerdas (189,190 acres). Growth is estimated at about 1.5 cords per acre, per year. The annual supply available for fiber utilization is estimated at 219,000 cords on the north slope and 73,500 cords on the south slope. Most of the supply is within 40 miles by highway from Ponce or Arecibo, although movement of material to a hard-surfaced road would probably be costly on much of the area.

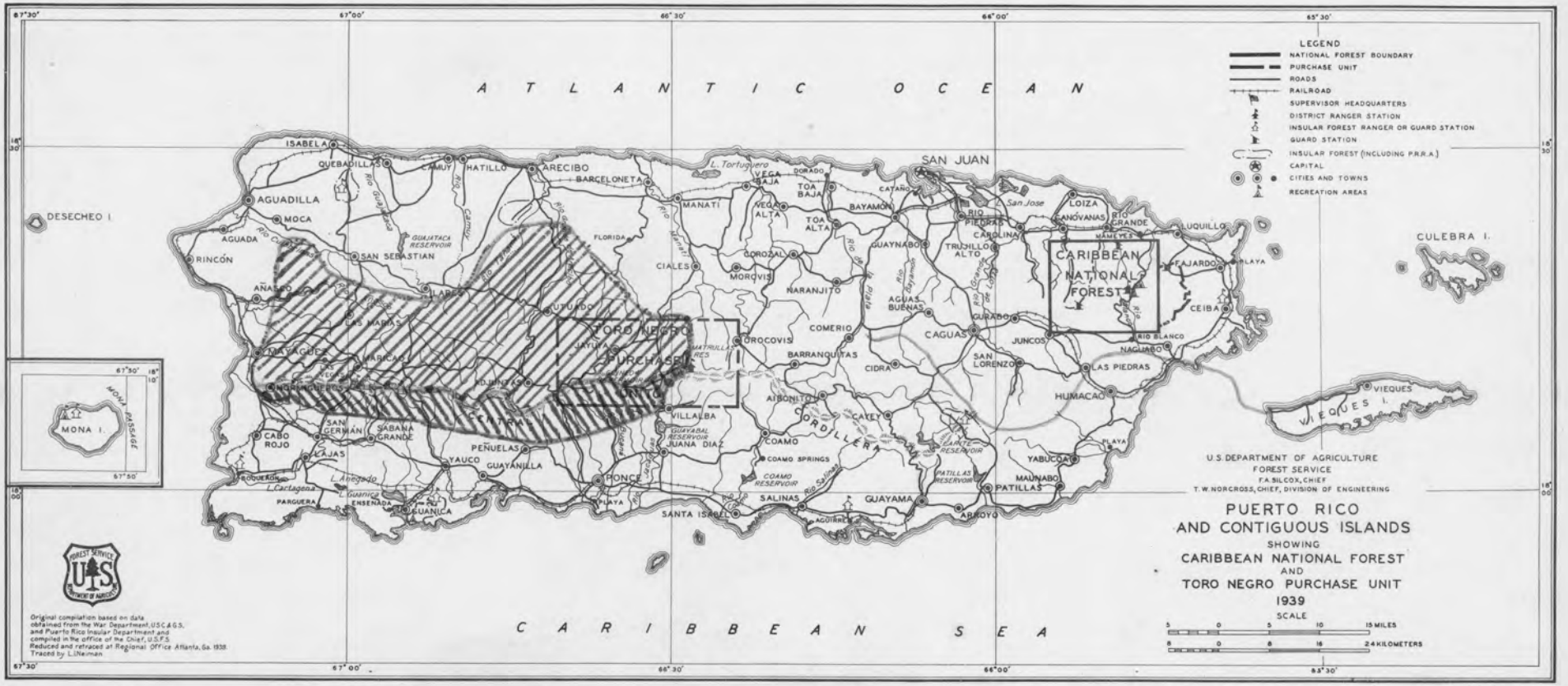
Forest Use

Unfortunately, little is known regarding the total growth, drain, and utilization of the Puerto Rico forests. Estimates have been made (3) totaling an annual utilization drain of 1,107,000 cords in 1945 and including 2,110 M board feet of saw timber. On the basis of the recent Insular inventory, these estimates appear high, but no good basis for complete revision is available. At that time, growth was estimated at 806,000 cords annually.

Currently, it is thought that the saw timber drain is only some 400 M to 500 M board feet annually. It is known that the fuelwood and charcoal drain has decreased greatly over the past years, largely because of the general use of kerosene for cooking, but the decrease cannot be estimated accurately. As an indicator, fuelwood and charcoal-wood sales on the National Forests in 1951 were only about 7 percent of the 1945 volume.

On the basis of these few facts and assumptions, it can be guessed that current annual utilization drain is about as follows:

	Cords
Saw timber, 500 M board feet or	1,000
Fuel and charcoal wood	80,000
Posts, ties, round construction material, etc.	3,000
Total	84,000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GUARD STATION
INSULAR FOREST (INCLUDING P.R.R.A.)
CAPITAL
CITIES AND TOWNS
RECREATION AREAS
CARIBBEAN NATIONAL FOREST
TORO NEGRO PURCHASE UNIT
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PUERTO RICO
AND CONTIGUOUS ISLANDS
SHOWING
CARIBBEAN NATIONAL FOREST
AND
TORO NEGRO PURCHASE UNIT
1939
SCALE
15 MILES
24 KILOMETERS
Original compilation based on data obtained from the War Department, U.S.C.& G.S. and Puerto Rico Insular Department and compiled in the office of the Chief, U.S.F.S. Reduced and retraced at Regional Office Atlanta, Ga. 1938. Traced by L.I.Newman.

Figure 2.--About 550,000 cords of material of pulpwood-size and quality, are available for utilization in western Puerto Rico within the cross-hatched area. It is estimated by the Tropical Region that a sustained annual cut of 219,000 cords could be made from the north slope and 73,500 cords from the south slope.

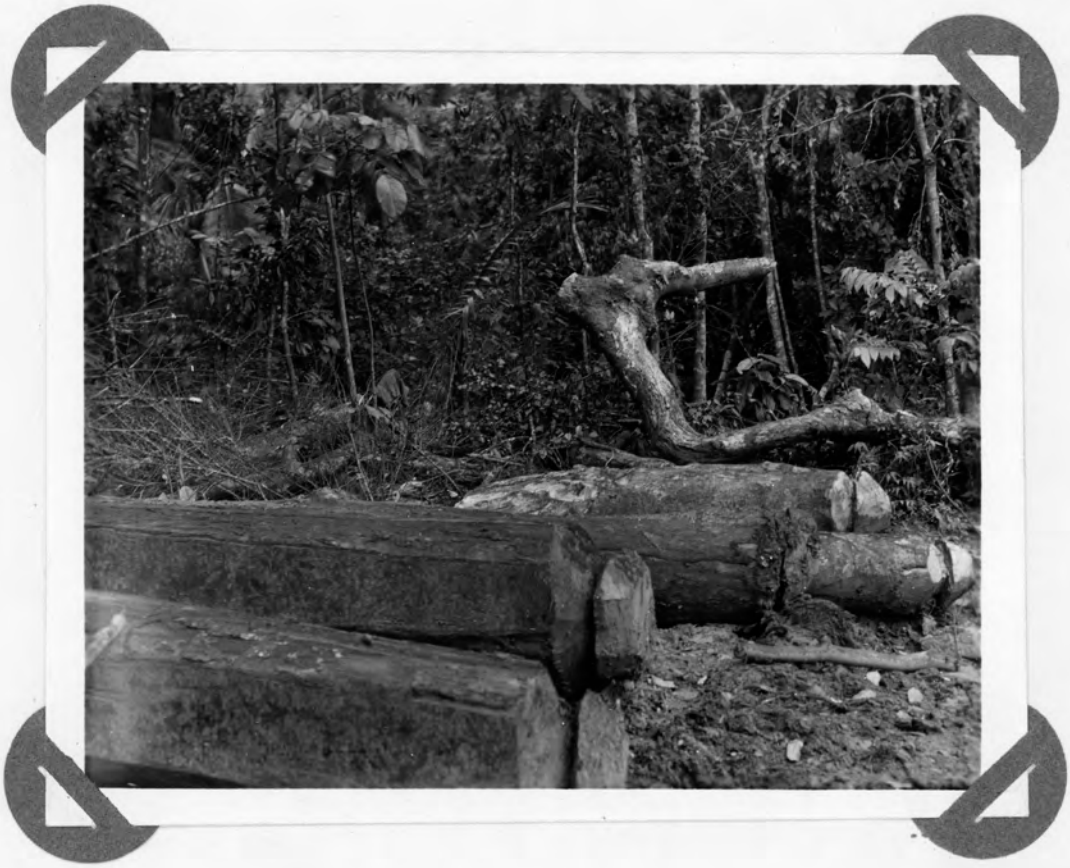

Figure 3.--Puerto Rico's saw-timber stand and drain are very small. These tabonuco, hand-slabbed logs were cut on the Luquillo District of the National Forest, and probably will be truck-hauled to the San Juan area for sawmill conversion into lumber for the furniture industry. (Photo. by F. H. Wadsworth, May 1952)

Forest Problems

From the foregoing, and from other miscellaneous sources, it is concluded that the major forest problems of Puerto Rico from a forest utilization viewpoint are:

1. The need for increased use of small, poor-quality and poor-form material.

This action is essential for reasons of (a) timber stand improvement to encourage a future forest crop of better quality, (b) to give an improved financial return to the owners of forest land, and (c) to improve the economy of the Island by reducing the value of wood imports.

2. The increased production of timber in sawlog size and of high-value form and species.

This need is largely the corollary of (1) the above and, in part, can only follow it. Execution in this field is mostly a function of activities related to forest management and extension.

3. The acceleration of factory tests, field experiments, field and laboratory research, etc., to add to the little information now available on the properties and uses of Puerto Rico's woods.

A recent bulletin (4) by the Insular Forest Service lists 31 Puerto Rico species as "most valuable," 63 species as of intermediate value, and 53 species as inferior. This classification is built up on a weak background of local-use information, literature references, specific gravity data, and a few laboratory studies. Species information needs to be supplemented and strengthened, partly to serve as a guide to forest management policy determinations.

FOREST UTILIZATION

An analysis of the forest utilization situation in Puerto Rico should have for its accomplishment objectives:

1. The maximum use of local wood supplies allowable under good practices of forest management;

2. The maximum utilization and service of domestic and imported wood materials and products; and

3. The maximum improvement of the Insular economy through increased local employment and decreased wood imports.

Figure 4.--A major forest problem is to increase the use of small, poor-quality and poor-form material. Somewhat typical of the problem is this white mangrove stand, Mangroves (Insular) Forest. (Photo. by F. H. Wadsworth, 1950)

The conditions, problems, and needs in the field of forest products utilization in Puerto Rico have to be considered against a background of the points made earlier, i.e.:

1. High population pressure against an agrarian economy has resulted in partial unemployment, low wages, and low standards of living -- by U. S. "normals" -- (but relative high standards if related to the Caribbean base), with the result that Puerto Rico is "priced out" of local, off-shore markets on many items);

2. A Spanish-colonial, tropical heritage of language, traditions, and work habits in a climate and economy where survival is easy and status improvement difficult;

3. A negative balance in both export trade (-$110,000,000 in 1950) and in total economy (-$204,000,000 in 1951); and

4. Forest supplies adequate to furnish only a small part (about 25 percent) of the wood needs of the population.

All of these factors are at variance with continental United States conditions and are related more closely to those of some European and Asiatic areas.

As a base for an analysis of forest products utilization practices and problems, it is highly important to have background information and data on forest volumes, growth and drain, forest products production, imports, and exports, and products consumption and waste by industries, etc. Of these items, authentic information is at hand only on forest volumes (table 7), imports (table 8), and exports.

Objectives should be established to obtain well-founded estimates or survey data on:

1. Utilization drain, total drain, and growth on Insular forests;

2. Consumption of forest products by industries (i.e., on the order of "Wood Used in Manufacture," plus construction and other non-fabricated uses); and

3. Estimates of waste by end-uses.

Wood Use and Raw Material Sources

On the basis of estimates, and some questionable assumptions, it is possible to draw a pattern of total Insular wood use, by sources of material. This is taken in part from estimates made in the previous section (p. 7), plus data available on imports of forest products (table 8).

Estimated Total Insular Wood Use

Material		Source						Total	
Item	Volume units	Domestic			Imported			In cord equivalents	
		Volume	Cords	Percent	Volume	Cords	Percent	Cords	Percent
Fuelwood and charcoal wood	Cords	80,000	80,000	95.2	.....	.....	.....	80,000	25.1
Saw timber and lumber and products	M bd. ft.	500	1,000	1.2	86,000	172,000	73.4	173,000	54.4
Posts, ties, round timbers, etc.	M bd. ft.	.....	3,000	3.6	3,000	6,000	2.5	9,000	2.8
Pulp and products	Tons	.....	.....	.....	37,600	56,400	24.1	56,400	17.7
Totals		.....	84,000	100.0	.....	234,400	100.0	318,400	100.0
Percent		.....	26.4		.....	73.6		100.0	100.0

The above is significant in since it indicates that:

1. About 74 percent of Puerto Rico's wood needs are filled with imported material;

2. The major volume of imports (73 percent) is in lumber and other saw-timber products, of which the Island has a very small supply; and

3. Imports of paper products are also a major item (about 24 percent) and are produced from the type of material of which there is a good Insular supply.

Insular Production

This section concerns itself mainly with the production of forest products on the Island and their primary utilization. The following section on "Wood Use" will cover the general utilization of both Insular and imported wood materials.

Fuelwood and Charcoal

Although kerosene and other fuels largely have replaced wood and charcoal, the consumption of wood for cooking purposes in Puerto Rico is still substantial. Timber sales records for the National and Insular Forests for 1951 show total fuelwood and charcoal-wood sales of $3,100, or about 2,300 cords. This amounts to 65 percent of the total volume sold on the public forests and 26 percent of the total value.

There is no organized fuel or charcoal industry and most of the consumption is in the rural areas. As concerns charcoal, conversion is an individual enterprise by means of the "beehive" or trench-type charring under a layer of dirt. Stumpage cost is $1+ per cord, yielding about 20, 40-pound sacks of charcoal. The gross return per cord is $6, or at the rate of $25 per ton of charcoal. The profit to the individual is about $5 for 2 days' work. The retail price of charcoal is around 80 cents per sack, or $40 per ton. Therefore, charcoal burning on the average does not pay a high return to the individual but is a fair source of income in a low-wage area.

There are two possibilities of improving Insular utilization and economics in the field of charcoal conversion. Given a wood supply in good volume per acre and an adequate market, it would be of interest to try out one of the newly developed, small-capacity charcoal kilns (the Connecticut kiln, for example). These kilns, when properly operated, provide somewhat more efficient burning, along with a significant increase in the yield of charcoal, when compared with "bee-hive" production.

Also worth investigating is the practicability of entering the United States market with charcoal briquets, since Puerto Rico has definite advantages in low wood and labor costs. To produce briquets would require an investiment of some $20,000 in kilns, briquetting machinery, dryer, and building for an operation producing about 10 tons daily. The product would compete in a continental United States price market of around $65 per ton. The current United States price of lump charcoal is about $45. The Forest Products Laboratory can supply more details and assistance in case there is local interest in these suggestions.

Figure 5.--Charcoal is produced by the old, "beehive" method. This particular "burn" was made in connection with a mangrove clear-cutting experiment. (Photo by F. H. Wadsworth, 1951)

Lumber

The minor volume (estimated at 500,000 board feet of which 150,000 is from the public forests) of lumber produced on the Island is mostly whipsawn. This archaic method of conversion actually is economical under the existing conditions of very rough logging terrain, widely scattered saw timber, and comparatively cheap labor. Whipsawing is done with surprising accuracy, usually plus or minus 1/16 inch on 4/4-inch boards.

Three sawmills are operated on the Island in the San Juan area and were visited. Probably each cuts less than 100 M board feet per year, in two cases doing mostly custom sawing for the furniture trade, and in the third case being operated by a wholesaler largely for sawing imported logs.

All three mills were fairly new and in good condition. None were being operated when visited. All were circulars with electric power and 40- to 46-inch saws. Sawing accuracy was good and only minor volumes of waste were in sight. In one case, edgings and trimmings were being converted into charcoal.

Local-use Material

The major items included in this group are fence posts, house posts (foundation posts), railroad ties, and poles (used mostly for building construction). These materials are generally used in the localities where cut, and, excepting for fence and house posts, supply only a small percent of the material needed for construction purposes.

Probably fence posts are the major volume item in this group. They are used in small size (2 inches is a common diameter) and at frequent intervals of spacing. All are untreated and have a general maximum life of 1 to 2 years. Stumpage cost is low (about 2-1/2 cents per post on the National Forests) and the supply is abundant.

Under conditions of low stumpage cost and cheap labor there is little incentive to invest in preservative post treatments. It is possible, however, that a demonstration program somewhat on the order of that used by the Tennessee Valley Authority -- using a mobile, open-tank plant (5) -- would increase interest and use in preservative treatments.

A partial solution of the problem of post deterioration and replacement is the wider use of the 12 to 15 native "sprouting species." When used green, these species root and produce fuel and shade as well as fence

Figure 6.--Whipsawing tabonuco on the Luquillo National Forest Unit. Because of very rough terrain, widely scattered timber and cheap labor, this is still an economical method of conversion. (Photo. by F. H. Wadsworth)

support. Although not applicable to temporary fencing, it may be that a more vigorous campaign to encourage the fence-line use of these species is justified. There are indications, however, that these species can be used economically only in noncrop-land fence lines. Some objections to their use have been raised for the reasons that crown growth shades crops and reduces yields. This whole problem should be investigated thoroughly and recommendations made available to land owners.

Native material in the form of posts in 6- to 8-inch diameters is used commonly for house foundations in the rural areas. These also are untreated and have a relatively short life. For this use, preservative treatment is more advantageous than when applied to fence posts and a demonstration program should pay better dividends.

Substantial numbers of narrow-gage railroad cross ties (for use in sugar-cane plantation track) are produced locally. These are also used untreated and have a short service life. Here, again, preservative treatment would be a definite economy.

Poles, for framing local buildings, are another item of local use. Use is without regard to size and species, assuming sufficient structural strength. Preservative treatment is not used but members are sometimes painted with "Carbolineum" or with asphalt. With good workmanship, excellent structures result. A warehouse 70 by 120 feet was noticed at Caguas, framed entirely with eucalyptus, roble, and tabonuco. The use of this type of construction could be expanded with profit to the Island, especially if facilities were available for preservative treatment.

Wood Use

This section will cover the uses of lumber and other wood and wood-fiber products consumed and remanufactured in Puerto Rico. Excluded is the utilization of native fuelwood, fence posts, and other local-use material discussed in the previous section.

Construction

By continental United States standards, the use of wood and lumber in building construction in Puerto Rico is small. Urban residences and buildings are masonry almost exclusively and the major wood use in cities is in forms and scaffolding, plus some volume in doors, frames, and other millwork. In rural areas, and to some extent in the cities, there is a considerable use for maintenance of structures.

Figure 7.--The use of native "sprouting species" is a partial solution to the fence post deterioration problem. The above posts are West Indian birch, placed 4 or 5 years ago in a Cambalache Experimental Forest fence line. (June, 1952)

Wood used in construction is made up mainly of the following imported items (see table 8):

Item	Unit	Quantity
Ties, hewn	M board foot	1,003
Ties, sawn	M board foot	812
Piles	Linear foot	51,260
Poles	No.	7,678
Lumber	M board foot	[3] 75,000
Millwork	Dollar	221,000
Plywood	M square foot	[4] 2,000.

Little comment is needed on construction uses. Ties are mostly creosoted. Piles are generally untreated but, according to Insular engineers, are used below water line and need no treatment. Poles also are treated. Bridges generally are of steel and concrete construction. Deterioration is in part by mechanical wear and in part by attacks from termites and fungi, these latter losses being avoidable by preservative treatment.

Furniture

The 1949 census shows the "Furniture and Fixtures" industry in Puerto Rico as employing 1,900 at 186 establishments and a "Value added by manufacture" as $2,300,000. Since the production of furniture is partly a small-shop industry, it is probable that the total number of establishments and employees far exceeds the number reported.

Again, it is impossible to estimate wood consumption. Obviously, most of the 2,600 M board feet of imported hardwood lumber shown in table 8 is used in furniture, plus the larger part of the Insular lumber production of about 500 M. Some imported softwood is used in the cheaper items.

If an average were drawn from the plants visited, it would show about 30 employees producing solid furniture using mostly air-dried mahogany lumber imported from Central America and from the other West Indies. Native woods are used to the maximum of availability, the favorites being -- somewhat in order -- tabonuco, laurel sabino, and capá prieto. (Guaraguaó, aceitillo, cedro macho, nuez moscada, and others also are used.)

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[3] Volume used cannot be estimated accurately. About 76,000 M bd. ft. of softwood lumber were imported in 1950, most of which probably was used in construction, including that remanufactured into millwork.

[4] Cannot be accurately estimated. About 2,220 M sq. ft. of softwood plywood were imported in 1950.

Figure 8.--The typical furniture factory uses small-sized equipment, does much hand work, has no factory trucks, and does the minimum of housekeeping. Note that this shop is cluttered with wood parts and sawdust. The bed posts at the left are native tabonuco and probably will become part of a bed sold as "mahogany". (June, 1952)

Figure 9.--Wood seasoning is given little attention by Puerto Rican fabricators. This modification of the furnace-type kiln was the only installation seen on the island. A few checks on moisture content found air-dried lumber going into furniture at 17 to 23 percent. (June 1952)

The industry uses "hobby-sized" equipment widely, does much hand work (especially in sanding and finishing), uses very few factory trucks or other labor-saving devices, has no dry kilns (one kiln was noted on the Island, heated by forced hot-air circulation through interior pipes), and has little knowledge of the moisture content of its materials or products. Many of the factory lay-outs are not well planned and plant housekeeping often is poor. The quality of work is generally good and moisture-resistant glues are used. Labor rates are low, about 40 cents per hour, (accounting in part for the lack of labor-saving equipment). The lack of interior heating with a uniformly high equilibrium moisture content (about 14 percent) reduces moisture content problems of furniture in service.

Waste in the industry probably is less than in the United States but is still substantial. Waste occurrence is difficult to evaluate because solid pieces usually are accumulated in a scrap stock pile and salvaged as production permits. There are almost no local markets for waste and it is seldom used for fuel.

Because of its resistance to the attack of the West Indian termite, solid mahogany furniture (Swietenia) is a public favorite. It is rather common practice in the industry to make beds of mahogany with the exception of the posts which usually are made from native tabonuco. Tabonuco can be bought in 4- by 4-inch sizes for about $260 per M board feet while mahogany is $400. Tabonuco has low termite resistance.

Most manufacturers are interested in expanding their use of domestic woods and some (e.g., Industrial Esteves, Aguadilla) will cooperate in trying out Puerto Rican species not used in the industry. The Aguadilla Company also is interested in buying round material of about 3-inch diameter for turning into chair legs, back posts, etc.

The practices of the industry could be materially improved by consulting services on shop lay-out and techniques, seasoning methods, the importance of moisture content, and on treatments to protect products from termite attack. Also, a survey should be made to determine the effects on service to the user of high moisture content, at the time of manufacture.

Millwork

According to the Bureau of the Census (1949), there are 43 millwork plants on the Island, employing 300 and adding a value of $590,000 to products. As in the furniture industry, some small shops produce millwork, but the bulk of the production is from establishments with 20 employees or more. The products are mainly doors, frames, transoms, and blinds.

Figure 10.--Furniture made in Puerto Rico looks good but may not always give good service. The above foot and head bed units are of Swietenia mahogany (resistant to attack by dry-wood termites), excepting for the tabonuco posts (which have low resistance). (June, 1952)

Production-size equipment is common. The use of labor-saving equipment and shop trucks is rare but found more frequently than in the furniture industry. Southern yellow pine is mostly used, followed by Douglas-fir, cypress, and redwood. Waste, for which there is little market, is available in relatively more volume than in the furniture industry. Unlike the furniture industry, millwork manufacturers have little interest in the use of local species, largely because of difficulty in buying domestic woods in standard sizes and grades.

Because of the decay and dry-wood termite hazards, some attention is given to preservative treatments. Two of the twelve plants visited had provision for dipping in pentachlorophenol. Doors were the only items being given treatment, which was a very casual one of short duration.

Much of the millwork made and used on the Island is supplied to the Puerto Rico Housing Authority. Procurement is administered by "Local Authorities," all buying under standard specifications issued by the main office at San Juan. Some of the provisions of these specifications appear to be unnecessarily restrictive, and to have some conflicting requirements on drying and on species. Quite probably building costs are increased by these specifications without a corresponding increase in service. If requested by the Housing Authority, these specifications could be reviewed by the Forest Products Laboratory and improved greatly.

Minor Industries and Uses

In total wood use the minor industries of the Island are of little importance. In total employment and in contributions to the economy of Puerto Rico, these industries are of importance and there is room for considerable expansion in this group.

The minor industries and activities observed are listed below.

Art work (wood signature desk blocks)
Brooms (both hand and machine made)
Folding cot beds
Ox carts
Repair shops (furniture, carts, trucks)
Toys (baseball bats)
Truck bodies
Miscellaneous (garment hangers, trunks, scrubbing boards, etc.)

In addition, wood is used in the manufacture and assembly of various types of containers and in caskets and coffins (some imported as finished items and many low-cost units made locally, largely from southern yellow pine).

Figure 11.---Millwork production is mostly by plants which are comparatively large and well-equipped. The above plant (Puerto Rico Sash and Door Co., San Turce) uses 20 M board feet of lumber per day. The factory truck and radial saw are unusual items in Puerto Rico. (June, 1952)

There is no general pattern for this group. The types of production units vary from that of the roadside blacksmith shop to a modern plant with automatic lathes and sanders. In general, imported woods are used but in some items native species dominate. The value of products varies widely.

A few of the plants visited were of special interest.

A small, highly mechanized, household-broom plant, operating in Hato Rey, buys all of its materials from the States. Handles cost 6.7 cents each. A home-industry broom plant in the vicinity of Aguadilla buys about 40 percent of its handles from the States, the other 60 percent being hand-peeled local woods. There seems to be an opportunity here to expand the use of small-sized, native, round material or to use waste from other operations.

Near Quebradillas an individual has specialized in the production of wood-signature desk blocks and appears to have been rather successful at it. Native species (capa blanco, maja, and tortugo) are used. He has considerable pride in his craft and pointed out with enthusiasm that wood raw material worth 25 cents is converted into a product selling for $50. This emphasizes the fact that craftsmen of this type are rare in Puerto Rico and that there is little production for the art, specialty, and tourist trades. Much of this type of product, especially novelty woodwork for tourist sale, is imported from Haiti or from other low-wage Caribbean sources with no benefit to native labor and materials in Puerto Rico. A limited program appears to be justified in the training of workers and in the expansion of production of art and novelty wood items.

At Ponce a plant was visited which produces annually about 750,000 toy baseball bats most of which go into the continental United States market. Bats are made in three sizes, the major items being turned from 1-1/2- by 1-1/2- by 19-inch and 1-3/4- by 1-3/4- by 24-inch ash, air-dried squares imported from the States. The unit cost of these squares is 5-1/2 cents and 6-1/4 cents, respectively, and ocean freight is about 1 cent per square, and 1 cent per bat on shipments to the United States. In spite of low labor costs, the manufacturer reported that he was operating at a marginal profit and that it was essential to find cheaper raw material. Here again is a possible use for small-sized, native, round material. A test might be arranged with the manufacturer to supply him with peeled, air-dry stock, which might require rough turning and further seasoning prior to finishing.

Paper and Products

About 37,600 tons of paper and related products were imported into Puerto Rico in 1950 (see table 8). These imports were made up of 52

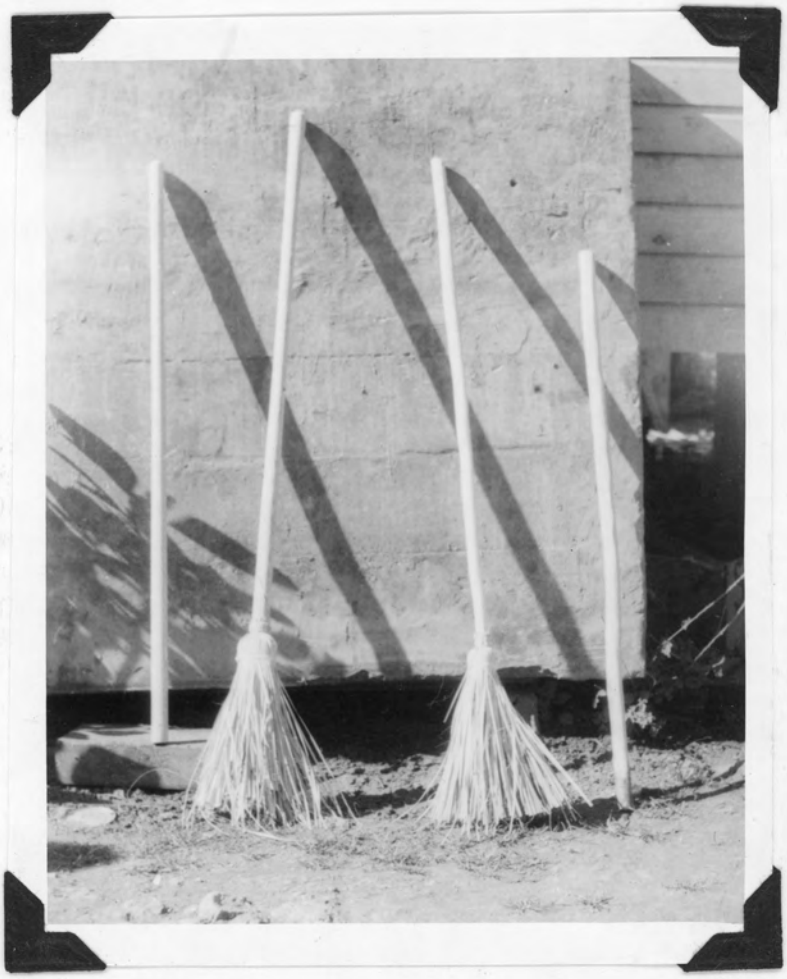

Figure 12.--The use of native woods can be increased in the broom industry. The two items at the left are handles imported from the States at a cost of about 7¢ each. The items at the right are native handles. (June 1952)

Figure 13.--Native woods with a value of 25 cents can be converted into a product selling for $50. Capá blanco, maja and tortugo have been used by a native craftsman in this signature replica. (June, 1952)

various items, but nearly 70 percent, or 25,000 tons, of the total was in three general classes of paper products, i.e.,

Newsprint (mostly Canadian)	7,400 tons
Kraft (paper, grocery bags, etc.)	11,600 tons
Container (liner, corrugating, bending, etc.)	6,000 tons
	25,000 tons

As emphasized previously, there is a wood raw material base on Puerto Rico for conversion into some type of pulp product. There is also available a tremendous volume of bagasse which, from the standpoint of Insular economics, is possibly a more important problem.

Indirectly as a result of the industrial expansion program of the Puerto Rico Economic Development Administration, a 50- to 70-ton mill is operating in the San Juan area producing liner board from waste paper. This plant (Puerto Rico Paper Products, Inc.) is managed by the Meade Corporation and has the objective of using bagasse as a raw material. A considerable tonnage of bagasse has been stock piled and an effort made to mix raw bagasse with waste paper pulp, apparently with poor success. Digesters are now on hand and the plan is to produce bagasse pulp by the soda process, aiming at corrugating board, bleached manila board, or food-package board. The use of paper waste may be continued on a reduced basis. A corrugating machine will be added and, eventually, the plant will produce fiber boxes.

The baling, transportation, and storage of bagasse are costly and complicated. Bagasse now in storage at Puerto Rico Paper Products has cost $11 to $12 per ton for baling and transportation only, and serious deterioration is expected. The Company management, therefore, is interested in a supplementary raw material source, especially during July through December when fresh bagasse is not available. During our visit, tentative arrangements were made between A. S. Boyers, General Manager of the Company, and Director Bosworth to run tests on a minimum of 2 cords of Puerto Rican woods (1 cord woods run and 1 cord of guamá or yagrumo) at the Meade Corporation laboratory in Chillicothe, Ohio. It seemed best not to involve the Forest Products Laboratory in this phase of testing. However, the Laboratory should be kept informed of progress and results and may have some suggestions to offer.

The Puerto Rico Economic Development Administration ("Fomento") is considering another approach to the bagasse utilization problem which may also involve the local wood supply. R. Fernández-García, Director, Department of Industrial Research, believes that one solution would be the establishment of a board mill at a sugar "central" with the general plan of producing board from bagasse for about 6 months in the year during the sugar season and using wood pulp for the remainder of the

year. He has in mind a building board, 1/2 inch thick, with a density somewhat higher than Celotex, treated to prevent attacks by termites and fungi. This procedure would eliminate the baling and transportation costs of moving bagasse to a distant plant, would eliminate the storage-deterioration problem, and, in theory, would permit the labor force from the sugar plantation and mill to move to the woods for employment during the off season.

It is to the interest of the Forest Service to follow up closely in the development of this proposal. If desirable, the Forest Products Laboratory and the Northern Regional Research Laboratory, Peoria, Ill., could assist cooperatively in research on a product containing various percentages of wood fiber and bagasse.

At this time there is no assurance that either of the above prospects will develop into an activity which will solve the problem of utilizing the small-size and low-quality material available from Puerto Rico's forests. It is desirable to plan, therefore, for some alternative action. More should be known about the quality and pulping properties of the 290,000 cords of wood estimated to be available on the western 40 percent of the Island. As a step in this direction it is suggested that, if the plans discussed above do not materialize, the Forest Products Laboratory schedule in Fiscal Year 1954 some work (small-scale tests) on one or two cords of material to be selected by the Tropical Region. Work should cover specific gravity, chemical analysis, the production of test sheets or samples, and general evaluations of the products for which the woods are best suited. Material might include 1/4 to 1/2 cord each of yagrumo, guamá and guaba, and one or two typical mixtures of species.

Factors Affecting Wood Use

Service conditions in Puerto Rico combine to effect rapid wood deterioration. An average temperature of about 76°, plus or minus about 3° during summer and winter, and associated with high relative humidity on much of the Island, result in short service life for untreated wood of low decay and termite resistance.

Puerto Rico is burdened with three species of termites -- the subterranean species (common in the States), the wet-wood termite (damaging only wood of high moisture content), and the West Indian dry-wood termite. The dry-wood species is in some ways the most damaging and difficult to combat, since it attacks wood without regard to location and needs no subterranean source of moisture. Damage by this species is especially important in furniture, and in interior and exterior woodwork. Some

residents of the Island think that the annual damage to furniture -- other than that made from the Swietenia mahoganies -- is between 5 and 10 percent per year. An Insular authority (6) has determined the relative resistance of most wood species grown and used on the Island with the result that on the basis of 100 as complete resistance, Swietenia mahogani is rated 80, S. macrophylla at 59, and most of the United States hardwoods at about 40 or lower. Many of the favorite Puerto Rico woods have low ratings, e.g.; tabonuco -- 31, laurel sabino -- 40, and nuez moscada -- 36. In better position are capá prieto -- 60, guaraguaó -- 70, and aceitillo -- 72.

Because of fungi attacks, untreated wood has a short life below ground. Post tests on 68 local species resulted in only a few being serviceable after 18 months exposure. Untreated wood in above ground locations also may have a comparatively short life because of fungi attacks, especially when exposed to frequent wettings by tropical showers.

These factors again point up the need in Puerto Rico for an expansion of preservative treatment facilities. It has been estimated (7) that there is an annual requirement for about 5,000,000 cubic feet of treated material on the Island and that the operation of a small pressure-treating plant probably is justified. This proposal has been turned over the the Puerto Rico Economic Development Administration, but no action has resulted. Probably the "Fomento" will take no action unless the proposal is followed up with a supplementary analysis of the need and economic practicability of establishing a commercial treating plant. This follow-up can be construed to be either a Fomento or a Forest Service responsibility.

It is also highly important that action be taken toward increasing the service life of furniture, millwork, and other items which are used out of contact with the soil. As concerns attacks by dry-wood termites, this problem has been studied by the Agricultural Experiment Station, University of Puerto Rico, and recommendations made (8). Probably the functions of the Forest Service in this field are:

1. To cooperate in an analysis of the research results of all agencies as concerns the practical solution of the problem in tropical climates;

2. To stimulate further research, if needed, by local agencies and by the U. S. Department of Agriculture; and

3. To stimulate and assist in demonstration and consultation activities.

One approach to the solution of this problem might be through joint action at the Washington Office and by the Bureau of Entomology, Plant Industry, and Forest Service. The objectives would be to discuss the problem, to plan further work, and to agree on activities aimed at result application.

ACCOMPLISHMENTS IN FOREST PRODUCTS RESEARCH

In view of the very limited funds and personnel available, much has been done since 1939 by the Tropical Region on the solution of its problems in the forest products field. Major accomplishments in this field were summarized in the April 1950 edition of "The Caribbean Forester," as given below:

1. Six important local species were sent to Duke and Yale Universities for testing, and reports on the results have been published.

2. Four inferior woods were found suited for boxes and crates.

3. The specific gravities of 109 local species were determined.

4. The equilibrium moisture content at Rio Piedras was determined for 84 local woods. The green moisture content was determined for 37 woods.

5. Tests of the native durability of fence posts of 68 species show that few remain serviceable after 18 months.

6. Piling of motillo (Sloanea berteriana Choisy) was found durable for at least 18 months in San Juan harbor.

7. Casuarina (Casuarina equisetifolia Forst.) was found susceptible to hot- and cold-bath treatment with carbolineum. After 8 hours of treatment and overnight cooling in the solution, the preservative had penetrated more than 1 inch and the treated posts are sound after 5-1/2 years.

8. A collection of the woods of 612 tropical tree species has been accumulated, including gifts from Ecuador and Surinam.

9. All available literature and unpublished information regarding the utility of 240 tree species of the Luquillo Mountains was compiled and the species were grouped in value classes for purposes of timber marking and cruise analysis.

Some further comments are needed to clarify the status, value, and need for expansion of this work.

Wood Properties

The tests of the six species mentioned (No. 1 above), plus one species tested at the Forest Products Laboratory, covered mechanical properties

and, in the Duke tests, the penetration and retention of coal tar creosote by tabonuco and Haitian pine. A relatively low priority should be given mechanical property tests at this stage of progress in research on the Puerto Rico woods and on other tropical hardwoods. Of much greater value is information on general utility properties, natural durability, treating characteristics, etc.

One of the major and most valuable contributions of the Tropical Region has been the work on specific gravity determinations (No. 3 above), since the results provide the best known single indicators of wood properties. Unfortunately, these determinations were made on oven-dry volumes and oven-dry weights, whereas, in order to estimate mechanical properties (T. B. 479) it is necessary to use gravities based on air-dry (12 percent) and oven-dry values. As a result, in estimating mechanical properties it was necessary to adjust specific gravities by assuming a standard volumetric shrinkage factor between 12 and 0 percent moisture content.

The value of past work on specific gravities is by no means nullified, since results provide a good method of comparison between the Puerto Rico species and United States species of known properties, especially in hardness, workability, nailing, etc. Estimates on mechanical properties are probably within the realm of usable accuracy and are not overly important.

It is important to continue work on specific gravity determinations and in considering future activities the following procedure is suggested:

1. First priority should be given to expanding data now available to include other species, especially those occurring in substantial volumes and those which are little used. (Determinations of specific gravity should be on both green volume, oven-dry weight and oven-dry volume, oven-dry weight with measurements on radial, tangential, and volumetric shrinkage);

2. Second priority might be redeterminations of specific gravities previously computed on the basis outlined above; and

3. Work should be aimed at fairly complete coverage of Puerto Rico species, possibly with the objective of a publication on the order of T. B. No. 158 "Comparative Strength Properties of Woods Grown in the United States," rather than at the more detailed T. B. 479, and supplemented with information or values on general utility properties.

Seasoning

In addition to considerable work on equilibrium and green moisture contents (No. 4 above), the rates of air seasoning have been studied on

four species. With the exception of work on air-seasoning rates, the impression is that this field has been given too much attention in relation to available manpower and to the potential applicability of results.

For future work consideration should be given to:

1. A study of seasoning practices in the wood-using industries, with emphasis on furniture, correlated with a study of service defects related to poor seasoning, and

2. If the study shows a need for improved seasoning, there is a possibility of introducing drying expedients, such as loft seasoning using solar heat (the Forest Products Laboratory will advise on this).

Natural Durability

A lot of good work (68 species -- Nos. 5 and 6 above) has been done in this field. No criticism is offered other than to question the value of including specimens which had been given a salt-water soaking treatment. Also, under this group should be added the work on 71 species in determining the natural resistance to attack by dry-wood termites, done in cooperation with the University of Puerto Rico Agricultural Experiment Station.

An extensive study is now under way to check on a common native theory that natural wood durability is related to the various phases of the moon and tide at the time of cutting. The Tropical Region has had some caustic comment on this study which is defensible on the grounds (a) results are needed as local demonstrations to overcome resistance to buying and cutting National Forest post material during the "wrong" phases of the moon, (b) little federal time or money was involved, and (c) other information on natural durability will accrue.

Preservative Treatments

This work has been expanded since reported in 1950 (No. 7 above) and now includes "graveyard" tests on 12 species treated by hot- and cold-bath and end diffusion, and 57 species by cold soaking in pentachlorophenol.

Results of this work generally have been favorable, many species have treated well and, in the case of hot- and cold-bath treatments, have given good service up to about 5 years of test. An exception has been the end-diffusion treatments with copperized-chlorinated zinc chloride in which 8 to 21 days were required for the posts to absorb the preservative. (Possibly results would have been better with zinc chloride.)

Treated posts were promptly attacked by termites, in preference to the untreated controls.

Supplementing work in Puerto Rico, an employee of the Insular Forest Service (Miguel A. Hernández) has been doing graduate work at the University of Michigan on 20 Puerto Rican species. The study involves cold soaking in penta and a corollary, anatomical study aimed at determining the causes for variations in penetration and absorption of the preservative.

Efforts in this field should now be switched to (a) a study of the utilization value and economic practicability of establishing commercial treating facilities on the Island, (b) the problem of above-ground deterioration, and (c) the stimulation of wider use, where applicable, of the "sprouting species" for fence posts.

Industrial Use

In this field efforts have been less intensive than is desirable. In addition to the use of motillo for piling (No. 6 above), and the trial of four species for box and crate material (No. 2 above -- results good but cost excessive), activities have included a commercial test (started in 1951) on the use of eucalyptus for piling, and a test in a Connecticut factory of six Puerto Rican species for use as textile spools (results poor).

Future work in Puerto Rico might include:

1. Factory tests of little-used species, especially those which give some promise of being suitable for furniture;

2. Trials of the use of small-sized, round material by the furniture industry and other; and

3. Pulping trials, as now contemplated in cooperation with the Puerto Rico Paper Products Company.

SUMMARY AND RECOMMENDATIONS

I. SUMMARY

A. Economic Background

Puerto Rico is 35 miles wide by 100 miles long, with an area of 3,435 square miles, about one-half that of New Jersey. The Island has an

agrarian tradition but only about one-half of the land is suited to agriculture uses and only about one-quarter should be cultivated continuously.

The 1950 population was 2.2 millions, also about one-half that of New Jersey. The population intensity is about 14 times that of the United States and the median income about 28 percent of the United States. Population is increasing at about twice the United States rate. Although employment increased by 73,000 between 1940 and 1950, unemployment also increased by 23,000.

Currently, Puerto Rico has almost no natural resources other than its soil, from which it derives about one-quarter of its direct income and on which it employs nearly 40 percent of its labor force. By far, the principal crop is sugar cane, followed by coffee and tobacco. Stimulated by the Insular Government in an effort to employ the rapidly increasing population, manufacturing provides about 14 percent of the Puerto Rican income and employs 20 percent of the labor force. Again, sugar products dominate the manufacturing industries.

Since 1935 Puerto Rico has been in an unfavorable exporting position, not because of a decline in exports but because of an increase in imports, most of which come from the United States. In 1950 the negative trade balance was $110 million. On the basis of income and expenditures, Puerto Rico in 1951 had a negative "external balance" of $204 million. That is, due mostly to United States grants, subsidies, etc., $204 million were spent on the Island in excess of the income earned there.

B. The Forests

Over 440 years of exploitation and population pressure have reduced the forest stands and the timber and wood supply to the point where they are inadequate to protect watersheds, much less to supply local needs.

The Island was originally completely forested, with an estimated volume of 7 billion cubic feet. The present forest area is some 650,000 acres, or about one-third of the total land area, although over 900,000 acres should be forested. This area is private land with the exception of 83,000 acres, or 12 percent, in National and Insular Forests. The total forest volume was estimated by the Insular Forest Service inventory at 131 million cubic feet, or about 2 percent of the original stand, of which only 8 percent is in saw timber qualities and sizes. About 25 percent of the total stand is in pole sizes, but mostly used as fuelwood, and 67 percent in fuel and pulpwood sizes. The annual drain on this supply is unknown but may be as low as 7.5 million cubic feet, in which case growth may exceed drain.

From the standpoint of forest utilization, the major forest problems are:

1. The need for increased use of small, poor-quality and poor-form material;

2. The increase production of timber in sawlog sizes and in high-value form and species; and

3. The acceleration of tests and research to add to the meager amount of information available on Puerto Rico's 600 tree species.

C. Forest Utilization

1. Wood Use and Raw Material Sources

No information is available on Insular forest growth, drain, or wood use other than on imports and exports. Total annual wood use is guessed at the equivalent of 318,000 cords (about 29 million cubic feet), or 22 percent of the total Insular supply. About 75 percent of this is imported, mostly from the States. Major 1950 import items were 80 million board feet of lumber and 37,600 tons of pulp and paper products. Forest products imported annually furnish employment elsewhere for 1,500 to 2,000 workers.

2. Insular Production

The major use of local wood is for fuel and charcoal although kerosene largely has replaced these items. Charcoal production is by "beehive" or pit burning. Possibly this industry can be revived by producing charcoal briquettes for the United States market.

Lumber is produced in minor volumes, mostly by whipsawing and largely for the furniture industry.

Fence posts, ties, house foundation posts, round framing members, etc., are cut in substantial volumes, used untreated, and have short service life.

3. Wood Use

a. Construction

Masonry has replaced wood in most urban building construction, but large volumes of lumber and millwork are used in rural areas and for

repair and maintenance. Deterioration by fungi and termites is substantial. Most other construction materials are treated in the United States.

b. Furniture

A large percentage of Puerto Rico's furniture is made locally, much of it in shops employing 2 to 5 persons. Mahogany (imported) and native woods are most commonly used. By United States standards, equipment, plant lay-out, shop practices, and seasoning methods are generally poor. Quality of hand work and the appearance of the product are good. Waste is mostly unutilized. Excepting for the use of termite-resistant mahogany, little attention is given to the protection of furniture from damage by dry-wood termites.

c. Millwork

Doors, frames, transoms, and blinds are produced locally in considerable volume, using mostly imported softwoods. Production is somewhat along lines followed in the furniture industry but tends to be centered in larger plants with better shop practices. Casual attention is given to the protection of products from decay and termite attack. Waste is not much utilized. Procurement specifications of the Puerto Rico Housing Authority need revision.

d. Minor Industries

These industries produce all sorts of products from art work to truck bodies. There seem to be expansion possibilities in the production of hand-carved items, novelties, etc., for the tourist trade, which are now mostly imported. A larger percentage of broom handles and other small parts could be made from native materials.

e. Paper and Products

All paper and products used (37,600 tons) are imported, while there is much material in the forests which should be removed and which probably can be used only by conversion to a wood-fiber product. Some action is now under way to use wood as a bagasse supplement in the production of paper and building board. The Forest Products Laboratory, in cooperation with the Northern (or other) Regional Research Laboratory, may be able to assist in these developments.

4. Factors Affecting General Wood Use

Climate in Puerto Rico encourages rapid wood deterioration by fungi attack, supplemented by attacks of dry-wood and subterranean termites. Excepting solid Swietenia mahogany items and parts, furniture deterioration by dry-wood termites may be 5 to 10 percent annually. No commercial facilities for preservative treatment exist on the Island and only a small percentage of the total wood used is treated. A detailed analysis should be made of the need and economic practicability of establishing commercial treating facilities. Action also should be taken, among the U.S.D.A. Bureaus concerned, to coordinate and stimulate activities related to wood service above ground.

D. Accomplishments in Forest Products Research

Accomplishments have been impressive in view of very limited funds and personnel. These accomplishments include:

1. Wood properties

   a. Mechanical properties data on seven species with pressure-treating data on two of the seven,

   b. Specific gravity determinations on 109 species, translated into estimated mechanical properties data on 75 species, and

   c. Utility classification ("good," "fair," and "poor") of 240 local species;

2. Seasoning

Equilibrium moisture contents were determined on 84 species, green moisture contents on 37 species, and the rate of air seasoning on 4 species;

3. Natural durability

   a. Fence-post exposure tests were made on 68 species,

   b. Cooperative tests on termite resistance were made on 71 species,

   c. A "moon-phase" study has been started involving "graveyard" exposure of a large number of fence posts;

4. Preservative treatments

   a. "Graveyard" tests are under way on 12 species treated by hot- and cold-bath and end diffusion,

b. Exposure tests have been started on 57 species treated with penta by cold soaking.

c. An Insular Forest Service employee has included 20 additional species in a graduate research problem involving cold soaking in penta;

5. Industrial use

a. Motillo and eucalyptus have been tested as piling.

b. Six Puerto Rican species have been found unsatisfactory for the production of textile spools.

c. Four species have been tried out for the production of boxes and crates.

II. RECOMMENDATIONS

In weighing the cost of carrying out these recommendations against potential activation value, consideration should be given to factors other than the normal major objective of accomplishing improved utilization of the forest crop, i.e.:

1. To a degree, Puerto Rico can be considered a "sample plot" for the Caribbean and tropical areas, and research and other activities initiated there can have wide tropical applicability;

2. Activation can contribute more directly and immediately to the solution of forest management plans and problems than is common to similar activities in the States and, to some extent, a forest products program is a prerequisite to forest management planning; and

3. The program can make substantial contributions to the economy of Puerto Rico and to the well-being of its people.

A. Forest Economics

Partly basic to analysis and action on the problems of forest management and forest products is the accumulation of more and better information on:

1. Growth and drain on Insular forests;

2. Consumption of forest products by industries; and

3. Estimates of industrial waste by end uses.

These problems relate to the Washington Office Division of Forest Economics and should be considered with that Division by the Tropical Region.

B. Forest Products

Problems in the field of forest products relate to demonstrations, survey and analyses, field and factory tests, and to field and laboratory research. For simplicity of reference, recommendations are listed by technical Divisions of the Forest Products Laboratory. In general, activities listed under "Field" should be done in Puerto Rico, and those listed under "Laboratory" should be done at the Forest Products Laboratory, or at some other qualified research institution. These activities are summarized and listed as follows:

1. Derived Products

(Field)

a. Investigate practicability of using small-unit charcoal kilns of Connecticut type (see p. 12);

b. Look into practical and economic possibility of establishing a charcoal briquetting operation contemplating the sale of the product in the United States market (see p. 12);

(Laboratory)

c. Assist and advise the Tropical Region in connection with the above;

2. Industrial Investigations

(Field)

a. Arrange factory tests on little-used Puerto Rican species, with special attention to the furniture industry (see p. 16);

b. Provide consulting service to the major units of Puerto Rican industry (mostly furniture and millwork) on problems such as plant layout, material handling, seasoning, moisture content determination, and preservative treatment (termite) (see p. 16);

c. Encourage the use of native, round material as a substitute for imported lumber in the Puerto Rican industries (see pp. 16, 17, 18);

d. Analyze demand for art, novelty, and specialty products, and, if found to be practical, encourage the production of these items. (see p. 18);

(Laboratory)

e. Give consulting service and assistance in connection with the above;

f. Make machining studies on several species, supplementing factory tests. Studies to cover planing, shaping, turning, sanding, boring, mortising, and sawing.

3. Pulp and Paper

(Field)

a. Follow up current possibilities on the use of wood fiber as a bagasse alternate with the Puerto Rico Pulp and Paper Co. and the Economic Development Administration (see p. 19);

b. In the event that these possibilities (a) do not develop, consider alternate action with the Forest Products Laboratory;

(Laboratory)

c. In conjunction with the above (a) cooperate, if requested with the Peoria Regional Research Laboratory in the research needed to produce a bagasse-wood-fiber board;

d. In conjunction with the above (b), consult with the Tropical Region on the most practical action toward encouraging a Puerto Rican wood-fiber industry;

e. If requested, make small-scale tests (in Fiscal Year 1954) on about 2 cords of material to be selected by the Tropical Region, e.g., 1/4 cord each of yagrumo, guamá and guaba, and of one or two typical mixtures of species;

4. Silvicultural Relations

(Field)

a. Continue work on specific gravity determinations, getting data on new species and making computations on both green and oven-dry volumes and on oven-dry weights. Radial, tangential, and volumetric shrinkage, from green to oven-dry, should be determined (see pp. 22, 23);

b. Make redeterminations of specific gravities computed previously (oven-dry volumes and weights only) on the basis of (a) the above (see p. 23);

c. Analyze the problems of growth-quality for a few important second-growth species in relation to present known uses and plans for management;

(Laboratory)

d. Assist, as requested, with the details of the above (a), (b), and (c);

e. Supplement the above (a) with a few increment core analyses and determine specific gravity and radial shrinkage. (Material to be accompanied by herbarium specimens);

5. Timber Mechanics

(Field)

a. Suggest to the Puerto Rico Housing Authority the advisability of review and modification of its specifications on the use of wood in Puerto Rican construction (see p. 17);

b. Analyze the practicability of a substantial expansion of the use of native pole-sized material as framing in building construction (see p. 14);

(Laboratory)

c. If requested, review Puerto Rico Housing Authority Specifications (a) above;

d. Following up on (b) above, consult with the Tropical Region on techniques and practices in using pole-sized, round materials in construction;

6. Timber Physics

(Field)

a. Analyze Insular seasoning practices and the effects of seasoning on the utility of Insular products, with special emphasis on furniture (see p. 16);

b. Consider, with the Forest Products Laboratory, the most effective methods of improving Insular seasoning practices (demonstrations, consulting activities, publications, etc.);

(Laboratory)

c. If indicated from the above (a), advise with Puerto Rican plants and the Tropical Region on expedients for lowering the moisture contents of lumber, e. g., loft drying using solar heat;

7. Wood Preservation

(Field)

a. Follow up on previous Forest Products Laboratory recommendations to determine the utilization value and economic practicability of

establishing a commercial treating plant in Puerto Rico. Correlate with the Puerto Rican Economic Development Administration (see p. 21).

b. Cooperate in analyzing the solution status on the problem of protecting wood items from termite and fungi attack when in service above ground, and stimulate and assist in the commercial use of suitable treatments. (Inter-Bureau action at the Washington Office level may be needed (see p. 21));

c. Determine, in cooperation with the Extension Service, the specific values of sprouting fence posts by species and their shading effects in reducing crop yields; stimulate their use where applicable (see pp. 13, 14);

d. Consider a limited demonstration program to encourage preservative treatment of fence posts and other local-use material. (Preliminary consultation with the Forest Products Laboratory would be desirable.) (See pp. 13, 14);

(Laboratory)

e. Assist and advise in connection with the above items (a through d); and

f. If requested in conjunction with the above (a), make a limited number of pressure-treatment tests on species selected by the Tropical Region.

C. Activation of Recommendations

The following are obvious:

1. A program of the type recommended will make slow and meager progress unless at least one, well-qualified, full-time man can be assigned to it at the Tropical Region;

2. Forest products research funds are not adequate to support this man in whole or in part; and

3. The program will contribute to the progress of forest management and to improving the economy of Puerto Rico, as well as to the accomplishment of forest products research objectives and to the general forestry program of the tropics.

The above recommendations (Section B) include 36 items of activity, of which 23 are largely a responsibility of the Tropical Region and 13 are assigned to the Forest Products Laboratory, or elsewhere, for research but which are partly dependent on corollary field activities.

Selection of priorities should be a decision of the Tropical Region but, in the opinion of the writer, should be somewhat as follows:

1. Expanded utilization of small, poor-quality and poor-form forest materials

   a. Concentration on Pulp and Paper items (Group 3, in the previous Section B), and

   b. Secondary attention to alternate uses such as charcoal (Group 1, Item b) and factory (Group 2, Item c);

2. Improved utilization and service of domestic and imported materials

   a. Concentration on the solution of the wood deterioration problem through preservative treatments and related activities (Group 7, especially Items a, b and c), and

   b. Secondary attention to improving factory and general use practices (Group 6, Item a and Group 5, Item a);

3. Accelerated research, with special emphasis on Caribbean and tropical applicability.

   a. Concentration on specific gravity determinations, and their translation into wood properties and potential uses (Group 4, Item a), and

   b. Assistance requests to the Forest Products Laboratory, and elsewhere, for research related to the total program and, especially, for research connected with current activities.

Table 1.--Net income of United States and Puerto Rico by industrial origin[1]

Industry	United States income (Billions of dollars)		Puerto Rico income (Millions of dollars)			
	1950	Percent	1945-1946	Percent	1950-1951	Percent
Agriculture	17.7	7.4	143.7	25.4	164.1	21.5
Manufacturing	74.1	31.0	74.7	13.2	105.7	13.9
Contract construction	12.2	5.1	8.6	1.5	23.1	3.0
Transportation	13.2	5.5	28.7	5.1	36.7	4.8
Trade	43.3	18.1	57.4	10.2	160.0	21.0
Services	22.0	9.2	45.2	8.0	65.6	8.6
Real Estate	20.3	8.5	30.4	5.4	28.8	3.8
Government	23.4	9.8	166.8	29.5	155.0	20.4
Other	12.8	5.4	16.8	3.0	22.8	3.0
Net international flow of capital returns	.....	.....	-7.3	-1.3	-14.4	-1.9
Totals	$239.0	100.0	$565.0	100.0	$747.4	100.0

[1] Information on "United States income" is taken from Appendix-Reference (9) and for "Puerto Rico income" from Reference (10).

Table 2.--Components of gross income and gross product of Puerto Rico[1]

Item	Fiscal year 1947	Fiscal year 1951
	Millions of dollars	Millions of dollars
Net Insular income	$612.4	$747.1
Depreciation	23.3	51.6
Business taxes	64.0	64.0
Statistical discrepancy	68.9	69.0
Government subsidies	-23.7	-18.4
Gross Insular product	$744.9	$913.3
Consumption expenditures (Food, clothing, housing, etc.)	$661.6	$808.7
Government purchases	142.3	177.4
Capital expenditures	98.6	131.3
Total expenditures	$902.5	$1,117.4
External balance	-$157.6	-$204.1

[1] See Appendix-Reference (10).

Table 3.--Employment status of Puerto Rico population[1]

(Thousands of persons 14 years old and older)

Group	April 1940	April 1950
Agriculture	229	251
Construction	16	26
Manufacturing	101	134
Transportation and communication	20	35
Trade	54	99
Services	66	84
Government	19	50
Other and not classified	7	6
Total employment	512	685
Emergency employment	24	2
Unemployed	66	89
Total labor force	602	776

[1] See Appendix-Reference (10).

Table 4.--Total production and gross income from agriculture[1]

	Fiscal year 1945	Fiscal year 1948
	Thousands of dollars	Thousands of dollars
Principal crops:		
Sugar cane	$64,147	$86,539
Molasses	1,812	3,787
Tobacco	9,307	7,643
Coffee	7,072	7,943
Subtotal	$82,338	$105,912
Livestock products	38,655	51,672
Legumes	3,277	3,883
Fruits	5,011	5,761
Starchy vegetables	16,722	16,924
Cereals	2,075	2,073
Other vegetables	2,258	2,920
Other products	6,455	5,387
Total	$156,791	$194,532

[1] See Appendix-Reference (10).

Table 5.--Manufacturing in Puerto Rico -- 1949[1]

Industry	Number of establishments	Number of employees	Value added by manufacture
		Thousands	Millions of dollars
Food and products	526	23.2	52.4
Tobacco	626	7.1	6.7
Textile	10	1.5-	.6
Apparel	263	10.8	9.3-
Lumber and wood	51	.3	.6
Furniture and fixtures	186	1.9	2.3
Paper and products	5	.3	.8
Printing and publishing	77	1.4+	3.7
Chemicals	49	1.3	4.4
Rubber products	1	.....	.....
Leather	22	.9	.9
Stone, clay, and glass	87	2.6	6.4-
Primary metal	1	.....	.....
Fabricated metal	33	.3	.7
Machinery	13	.6	1.4-
Electrical equipment	1	.....	.....
Transportation equipment	1	.....	.....
Instruments	2	.....	.....
Miscellaneous	44	2.4	2.5-
Totals	1,998	55.1	93.4

[1] See Appendix-Reference (11).

Table 6.--Value of Puerto Rican imports and exports of forest products[1]

(Fiscal Year 1950)

	Imports		Exports		Balance
	From United States	Other	To United States	Other	
	In thousands of dollars				
Wood, unmanufactured	239.3	29.3	.....	.....	-268.6
Sawmill products	5,437.7	759.9	.....	1.4	-6,196.2
Wood, manufactures	2,744.4	175.0	81.8	26.4	-2,811.2
Cork and manufactures	173.5	33.2	.....	.2	-206.5
Paper-base stocks	10.0	.....	.....	4.3	-5.7
Paper and related products	6,559.6	675.4	22.4	330.3	-6,882.3
Total	15,164.5	1,672.8	104.2	362.6	-16,370.5

[1] See Appendix-Reference (10).

Table 7.--Wood volume on forest lands in Puerto Rico

(As estimated by the Puerto Rico Forest Service in its 1948-1951 inventory survey)

Forest types	Areas	Volume			
		Sawtimber		Poles	Fuelwood
	M acres	M bd. ft.	M cu. ft.	M cu. ft.	M cu. ft.
Timber (or forest)	84.0	22,320	3,335	14,820	39,125
Coffee shade trees	192.0	37,448	5,600	.....	24,782
Woodland pasture	43.8	9,580	1,430	6,805	13,130
Mangrove swamps	18.0	.....	.....	10,970	10,972
Totals	337.8	(69,348)	10,365	32,595	88,009
Percent	.....	(7.9)	7.9	24.9	67.2
Total cubic feet	.....	.....	.....	.....	130,969

Notes on Table 7

1. As reported by the survey, volumes were given in both board feet and cubic feet for sawtimber. The latter volume included the sawlog volume of sawtimber trees and, also, the volume in tops and branches of this type tree. As given here, sawlog volume has been estimated in cubic feet using a factor of 6.7 board feet equals 1 cubic foot (supplied by the Tropical Region). The balance of volume reported for "Sawtimber" has been added to "Fuelwood".

2. The survey included a total area of only about 338,000 acres, out of an estimated minimum of 600,000 acres of forest-type land. Excluded were the following:

	Acres
Reproduction areas -- mostly with little volume, or bearing trees smaller than a 4-inch diameter at breast height or less than 10 feet in height.	17,500
Orchards -- mainly coconut plantations, plus, citrus, bay rum, and mangroves; little commercial wood volume.	9,400
Other forest land -- brush, shifting cultivation, or natural pasture.	347,200
Total	374,100

3. In classifying material as to utility the following definitions were used:

Sawtimber -- trees of 10-inch diameter at breast height and larger and of such form as to be suited for conversion into lumber.

Poles -- trees of 6-inch through 9.9-inch diameter at breast height and of such form as to be suitable for this use.

Fuelwood -- all material not suited for a higher use and of a diameter breast height of 3.6 inches and larger.

4. Excluded from the survey was the wood volume of ornamental trees, fruit trees, roadside and fence-line trees, and the volumes of stands of less than one cuerda (0.9712 acres).

Table 8.--Volume of Puerto Rican imports of forest products[1]

(Fiscal Year 1950)

Item	Unit	From United States	From other	Total	M board feet equivalent
Wood, unmanufactured:					
Logs, bolts, etc.	M bd. ft.	8		8	8
Ties hewn	M bd. ft.	485	518	1,003	1,003
Posts	No.		3,000	3,000	21
Piles	lin. ft.	51,260		51,260	260
Poles	No.	7,678		7,678	1,115
Other	dollars	48,139	10,276	58,415	585
Total -- Unmanufactured					2,992
Sawmill products:					
Softwood lumber:					
Douglas-fir:					
Rough	M bd. ft.	8,484	3,354	11,838	11,838
Worked	M bd. ft.	2,851	1,652	4,503	4,503
Southern pine:					
Rough or dressed	M bd. ft.	54,046		54,046	54,046
White pine	M bd. ft.	8		8	8
Redwood	M bd. ft.	3		3	3
Western hemlock	M bd. ft.	143	23	166	166
Post oak cedar	M bd. ft.	6	265	271	271
Other cedar	M bd. ft.	104	32	136	136
Cypress	M bd. ft.	487		487	487
Pines, other	M bd. ft.		5,017	5,017	5,017

Table 8.--Volume of Puerto Rican imports of forest products[1] (Continued)

(Fiscal Year 1950)

Item	Unit	From United States	From other	Total	M board feet equivalent
Hardwood lumber, etc.:					
Ash	M bd. ft.	34		34	34
Elm	M bd. ft.	103		103	103
Gum, black and tupelo	M bd. ft.	2		2	2
Mahogany	M bd. ft.	1,632	751	2,383	2,383
Oak	M bd. ft.	27		27	27
Yellow poplar	M bd. ft.	2		2	2
Other	M bd. ft.	21	44	63	63
Hardwood flooring	M bd. ft.	39		39	39
Small dimension	M bd. ft.	7		7	7
Railroad and mine ties	M bd. ft.	812		812	812
Total -- Lumber					79,949
Wood manufactures:					
Wood containers:					
Sawed shook	M bd. ft.	554		554	554
Other shook	dollars	30,867		30,867	175
Veneer packages	dollars	25,116		25,116	140
Lumber and plywood	dollars	18,121		18,121	100
Tight bushels	set	3,497		3,497	70
Tight bushels	No.	12,710	148	12,958	260
Other	dollars	260	523	783	4
Total -- Containers					1,303

Table 8.--Volume of Puerto Rican imports of forest products[1] (Continued)

(Fiscal Year 1950)

Item	Unit	From United States	From other	Total	M board feet equivalent
Plywood and veneer:					
Veneer	dollars	5,117			10
Douglas-fir	sq. ft.	1,528,315	669,488	2,197,803	1,100
Other softwood	sq. ft.	22,208		22,208	10
Hardwood	sq. ft.	291,215		291,215	140
Special	sq. ft.	44,772		44,772	20
Total -- Plywood and veneer					1,280
Millwork:					
Doors	No.	3,301		3,301	
Window sash	No.	30		30	
Window and door frames	No.	391		391	
Blinds	No.	662		662	
Trim and moldings	lin. ft.	1,462,649		1,462,649	
Slate	dollars	165		165	
Venetian blinds	No.	549		549	
Other	dollars	55,341		55,341	
Total -- Millwork					630
Structures:					
Prefabricated houses	dollars	168		168	1
Wood pipe, etc.	M bd. ft.	6		6	6
Total -- Structures					7

Table 8.--Volume of Puerto Rican imports of forest products[1] (Continued)

(Fiscal Year 1950)

Item	Unit	From United States	From other	Total	M board feet equivalent
Furniture:					
Office and store	dollars	137,318		137,318	
Other wood	dollars	1,502,623	16,422	1,519,045	
Rattan, reed, etc.	dollars	101,170	29,431	130,601	
Total -- Furniture					2,200
Miscellaneous:					
Boat oars and paddles	No.	353		353	
Lasts	pair	3,905		3,905	
Handles:					
Plow	doz.	8		8	
Long	doz.	30,519		30,519	
Striking	doz.	5,629		5,629	
Other	doz.	554		554	
Battery separators	M	19		19	
Bamboo, cane, etc.	dollars	2,198	40,998	43,196	
Woodenware	dollars	26,888		26,888	
Other	dollars	256,687	15,997	272,684	
Total -- Miscellaneous					670
Total -- Wood					59,029
Paper-base stocks:					
Waste paper	lbs.	430,354		430,354	

Table 8.--Volume of Puerto Rican imports of forest products[1] (Continued)

(Fiscal Year 1950)

Item	Unit	From United States	From other	Total	M board feet equivalent
Paper and related products:					
Paper:					
Newsprint	lb.	393,821	14,385,252	14,779,073	
Groundwood	lb.	796,089		796,089	
Book	lb.	2,129,530		2,129,530	
Fine:					
Writing	lb.	1,673,323	861	1,674,184	
Other	lb.	206,427	2,470	208,897	
Coarse:					
Kraft	lb.	13,187,691		13,187,691	
Glassene, etc	lb.	96,423		96,423	
Other	lb.	5,410,144		5,410,144	
Special and miscellaneous	lb.	343,772	6,943	350,715	
Total -- Paper					(See below)
Paperboard:					
Container board:					
Liners	lb.	835,349		835,349	
Corrugating	lb.	1,060,965		1,060,965	
Bending board	lb.	1,976,936		1,976,936	
Other	lb.	8,288,115	151	8,288,266	
Total -- Paperboard					(See below)

Table 8.--Volume of Puerto Rican imports of forest products[1] (Continued)

(Fiscal Year 1950)

Item	Unit	From United States	From other	Total	M board feet equivalent
Wet machine board	lb.	25,847		25,847	
Building board and insulation	lb.	1,401,969		1,401,969	
Converted paper and board products:					
Tablets, etc.	lb.	1,583,791		1,583,791	
Bags, grocery, etc.	lb.	9,918,021		9,918,021	
Shipping containers	lb.	1,807,254		1,807,254	
Boxes and cartons	lb.	1,172,763		1,172,763	
Food containers	lb.	1,383,038		1,383,038	
Toilet paper	lb.	1,146,998		1,146,998	
Other and miscellaneous	lb.	5,469,079	3,600	5,472,679	
Total -- Converted					(See below)
Total -- Paper and products				75,136,976	
Tons				37,600	
Cords (X 1.5)				56,400	28,200
Total -- Wood and Paper					117,200

[1]See Appendix-Reference (10). In converting to board feet from other units, the following values were used: Posts - 7 bd. ft. each; piles - 5 bd. ft. per lin. ft.; poles - 150 bd. ft. per pole; shook, veneer and lumber containers, $175 per M bd. ft.; barrels - 20 bd. ft. per unit; plywood - .5 bd. ft. per sq. ft.; millwork - $350 value equals 1 M bd. ft.; furniture - $800 value equals 1 M bd. ft.; miscellaneous - $500 value equals 1 M bd. ft.